Pitfalls in Acoustic Transducer Modeling for Focused Ultrasound (FUS)

Pasquinelli, Cristina; Montanaro, Hazael; Neufeld, Esra; Poni, Redi; Kuster, Niels; Thielscher, Axel

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

Citation (APA):
Pasquinelli, C., Montanaro, H., Neufeld, E., Poni, R., Kuster, N., & Thielscher, A. (2018). *Pitfalls in Acoustic Transducer Modeling for Focused Ultrasound (FUS)*. Abstract from 32nd Annual Meeting of the European Society for Hyperthermic Oncology, Berlin, Germany.

056

Pitfalls in Acoustic Transducer Modeling for Focused Ultrasound (FUS)

Pasquinelli C. [1], Montanaro H. [2], Neufeld E. [3], Poni R.[3], Kuster N. [2], Thielscher A. [1]
[1]DTU, Kongens Lyngby, Denmark
[2]ITIS / ETHZ, Zurich, Switzerland
[3]ITIS, Zurich, Switzerland

Introduction

When modeling therapeutic applications of FUS, the transducer is typically modelled by modeling the transducer surface geometry and imposing a pressure or velocity boundary condition (depending on the solver type). However, during experimental validation of transcranial FUS modeling, dramatic deviations between simulated and measured pressure distributions were observed that were shown to originate from transducer modeling.

Objectives

A systematic study was performed to investigate the impact of factors to be considered to obtain realistic models of acoustic exposure by US transducers.

Materials & methods

Acoustic pressure fields generated by curved single-element focused transducers (0.5 MHz) in the presence and absence of skull obstacles (pig, sheep, and lamb; characterized by CT and precisely positioned) have been measured using a 3D-scannable, calibrated hydrophone and compared to acoustic simulations of corresponding setup models. Initially the source was modelled as pressure boundary condition imposed on the transducer surface according to the manufacturer specifications. Subsequently, the model was adapted to consider the actually measured geometry, the internal structure of the transducer (planar piezoelectric disk below a shaped matching material), uncertainty about the internal transducer geometry and material properties, and an aperture function accounting for the mechanical impact of, e.g., the transducer wall.

Results

The pressure field sensitivity to the above factors was investigated and after careful model adaptation, good agreement between the simulated and measured fields was obtained in the absence of skulls. Significant deviations are still observed in the presence of skulls and current work focuses on establishing whether they originate from transducer modeling, or from the employed mapping of CT data to acoustic property distributions.

Conclusion

Careful transducer modeling and experimental validation is crucial to reliably simulate FUS fields and common approaches are found to be unsuitable for extended, curved or complex transducers.

Figure 1